Optical Patch Panel	
TR-303 DLC	Low density DLC
$1000	$1000

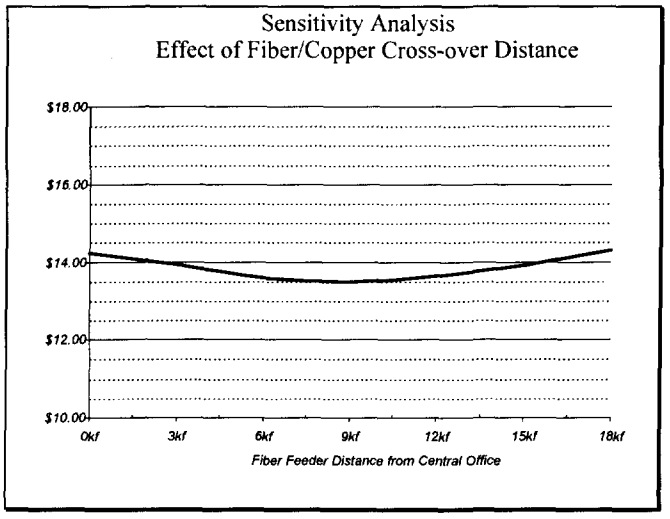
Support: The cost for an installed fiber optic patch panel, including splicing of the fibers to pigtails, was estimated by a team of experienced outside plant experts who have contracted for hundreds of such installations. A fiber optic patch panel contains no electronic, nor moving parts, but allows for the physical cross connection of fiber pigtails.

3.5.10. Copper Feeder Maximum Distance, feet

Definition: The feeder length above which fiber feeder cable is used in lieu of copper cable.

Default Value: 9,000 ft.

Support: Multiple sensitivity runs of the Hatfield Model, wherein the only variable changed is the copper/fiber maximum distance point, indicate a cost minimum point at approximately 9,000 feet.



3.5.11. Common Equipment Investment per Additional Line Increment

Definition: The cost of the common equipment required to add a line module in a remote terminal.

Default Values:

Common Equipment Investment per Additional Line Increment	
672	96
$18,500	$11,000

Support: The cost of an additional increment of Integrated Digital Loop Electronics was estimated by a team of experienced outside plant experts who have contracted for hundreds of Remote Terminal site installations. Low Density DLC requires less initial investment.

3.5.12. Maximum Number of Additional Line Modules per Remote Terminal

Definition: The number of line modules (in increments of 672 or 96 lines) that can be added to a remote terminal.

Default Values:

Max. # Add. Line Modules/RT	
TR-303 DLC	Low density DLC
2	1

Support: A standard OC-3 multiplexed site can provide up to 3 OC-1 systems, each at 672 lines. The Hatfield Model allows for adding 2 additional Common Equipment Investment modules to an initial 672 line system, and 1 additional Common Equipment Investment modules to an initial 96 line system.

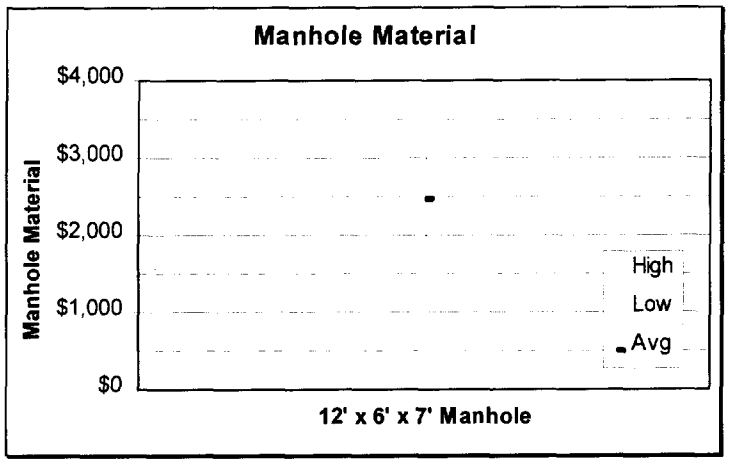
3.6. MANHOLE INVESTMENT – COPPER FEEDER

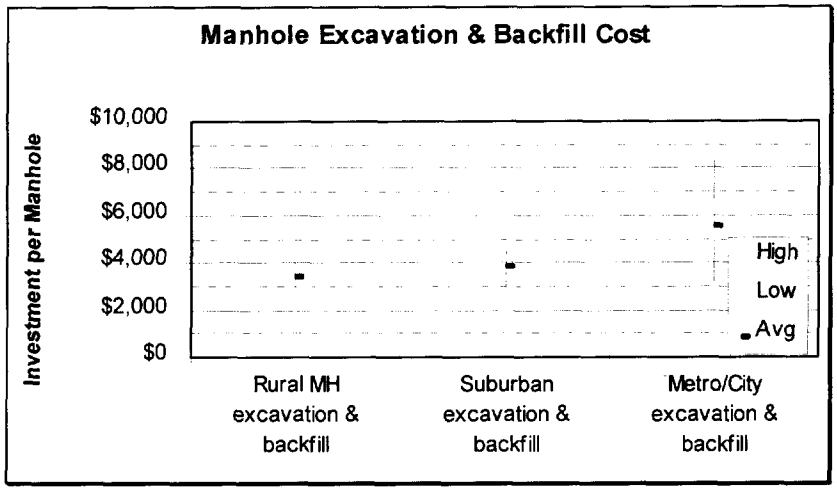
Definition: The installed cost of a prefabricated concrete manhole, including backfill and restoration. All the non-italicized costs in the following table are separately adjustable.

Default Values:

Copper Cable Manhole Investment						
Density Zone	Materials	Frame & Cover	Site Delivery	Total Material	Excavation & Backfill	Total Installed Manhole
0-5	$1,865	$350	$125	*$2,340*	$2,800	*$5,140*
5-100	$1,865	$350	$125	*$2,340*	$2,800	*$5,140*
100-200	$1,865	$350	$125	*$2,340*	$2,800	*$5,140*
200-650	$1,865	$350	$125	*$2,340*	$2,800	*$5,140*
650-850	$1,865	$350	$125	*$2,340*	$3,200	*$5,540*
850-2,550	$1,865	$350	$125	*$2,340*	$3,500	*$5,840*
2,550-5,000	$1,865	$350	$125	*$2,340*	$3,500	*$5,840*
5,000-10,000	$1,865	$350	$125	*$2,340*	$5,000	*$7,340*
10,000+	$1,865	$350	$125	*$2,340*	$5,000	*$7,340*

Support: Costs for various excavation methods were estimated by a team of experienced outside plant experts. Additional information was obtained from printed resources. Still other information was provided by several contractors who routinely perform excavation, conduit, and manhole placement work for telephone companies. Results of those inquiries are revealed in the following charts.





3.7. PULLBOX INVESTMENT – FIBER FEEDER

Definition: The investment per fiber pullbox in the feeder portion of the network.

Default Values:

Fiber Pullbox Investment		
Density Zone	Pullbox Materials	Pullbox Installation
0-5	$280	$220
5-100	$280	$220
100-200	$280	$220
200-650	$280	$220
650-850	$280	$220
850-2,550	$280	$220
2,550-5,000	$280	$220
5,000-10,000	$280	$220
10,000+	$280	$220

Support: The information was received verbally from a gentleman who identified himself as a Vice President of PenCell Corporation at their Supercom '96 booth. He stated a price of approximately $280 for

one of their larger boxes, without a large corporate purchase discount. Including installation, HM 3.1 uses a default value of $500.

4. SWITCHING AND INTEROFFICE TRANSMISSION PARAMETERS

4.1. END OFFICE SWITCHING

4.1.1. Switch real-time limit, busy hour call attempts

Definition: The maximum number of busy hour call attempts (BHCA) a switch can handle. If the model determines that the load on a processor, calculated as the number of busy hour call attempts times the processor feature load multiplier, exceeds the switch real time limit multiplied by the switch maximum processor occupancy, it will add a switch to the wire center.

Default Values:

Switch Real-time limit, BHCA	
Lines Served	**BHCA**
1-1,000	10,000
1,000-10,000	50,000
10,000-40,000	200,000
40,000+	600,000

Support: Industry experience and expertise of Hatfield Associates. These numbers are well within the range of the BHCA limitations NORTEL supplies in its Web site.[20]

Busy Hour Call Attempt Limits from Northern Telecom Internet Site	
Processor Series	**BHCA**
SuperNode Series 10	200,000
SuperNode Series 20	440,000
SuperNode Series 30	660,000
SuperNode Series 40	800,000
SuperNode Series 50 (RISC)	1,200,000
SuperNode Series 60 (RISC)	1,400,000 (burst mode)

4.1.2. Switch traffic limit, BHCCS

Definition: The maximum amount of traffic, measured in hundreds of call seconds (CCS), the switch can carry in the busy hour (BH).

If the model determines that the offered traffic load on an end office switching network exceeds the traffic limit, it will add a switch.

Default Values:

[20] http://www.nortel.com

Lines	Busy Hour CCS
1-1,000	30,000
1,000-10,000	150,000
10,000-40,000	600,000
40,000+	1,800,000

Support: Values selected to be consistent with BHCA limit assuming an average holding time of five minutes.

4.1.3. Switch maximum equipped line size

Definition: The maximum number of lines plus trunk ports that a typical digital switching machine can support.

Default Value: 80,000

Support: This is a conservative assumption based on industry common knowledge and the Lucent Technologies web site.[21] The site states that the 5ESS-2000 can provide service for "up to as many as 100,000 lines but can be engineered even larger." The Hatfield Model lowers the 100,000 to 80,000, or 80 percent, recognizing that planners will not typically assume the full capacity of the switch can be used.

4.1.4. Switch port administrative fill

Definition: The percent of lines in a switch that are assigned to subscribers compared to the total equipped lines in a switch.

Default Value: 0.98

4.1.5. Switch maximum processor occupancy

Definition: The fraction of total capacity (measured in busy hour call attempts, BHCA) an end office switch is allowed to carry before the model adds another switch.

Default Value: 0.90

Support: Bell Communications Research, *LATA Switching Systems Generic Requirements*, Section 17: Traffic Capacity and Environment, TR-TSY-000517, Issue 3, March 1989, figure 17.5-1, p. 17-24.

4.1.6. MDF/Protector Investment per Line

Definition: The Main Distribution Frame investment, including protector, required to terminate one line. According to Lucent's Web cite, A main distribution frame is "a framework used to cross-connect outside plant cable pairs to central office switching equipment, but also carrier facility equipment such as Office Repeater Bays and SLC[R] Carrier Central Office Terminals. The MDF is usually used to provide protection and test access to the outside plant cable pairs."

Default Value: $17.50

4.1.7. Analog Line Circuit Offset for DLC lines, per line

Definition: The reduction in per line switch investment resulting from the fact that line cards are not required in both the switch and remote terminal for DLC-served lines.

[21] See Lucent's Web site at http://www.lucent.com/netsys/5ESS/5esswtch.html

Default Value: $5.00

Support: This is a Hatfield Associates estimate, which is used in lieu of forward looking alternatives from public sources or ILECs. It is based on consultations with AT&T and MCI subject matter experts.

4.1.8. Switch installation multiplier

Definition: The telephone company investment in switch engineering and installation activities, expressed as a multiplier of the switch investment.

Default Value: 1.10

Support: The 10% factor used in the Hatfield model was derived based on the following information: Bell Atlantic ONA filing (FCC Docket 92-91) on February 13, 1992, showed a range of engineering factors for the different Bell Atlantic states between .08 and .108. The SBC ONA filing (FCC Docket 92-91) on May 18, 1992, showed a range of engineering and plant labor factors added together between .0879 and .1288. The 10% incremental-based factor is a conservative estimate, given the ranges filed by two RBOCs using traditional ARMIS-based embedded cost factor development.

4.1.9. End Office Switching Investment Constant Term

Definition: The value of the constant appearing in the function that calculates the per line switching investment as a function of switch line size, expressed separately for BOCs and large independents and for small independents.

Default Values: BOC and large ICO - $242.73
Small ICO - $416.11

Support: The switching cost surveys were developed using typical per-line prices paid by BOCs, GTE and other independents as reported in the Northern Business Information (NBI) publication, "U.S., Central Office Equipment Market: 1995 Database."[22] In addition, public line and switch data from the ARMIS 43-07 report are employed as well. See, Hatfield Model Release 3.1 Model Description, p. 43-46.

4.1.10. Processor feature loading multiplier

Definition: The amount by which the load on a processor exceeds the load associated with ordinary telephone calls, due to the presence of vertical features, Centrex, etc., expressed as a multiplier of nominal load.

Default Value: 1.20 for business line percentage up to the variable business penetration rate, increasing linearly above that rate to a final value of 2.00 for 100% business lines.

Support: This is a Hatfield Associates estimate, which is used in lieu of forward looking alternatives from public sources or ILECs. It is based on consultations with AT&T and MCI subject matter experts.

4.1.11. Business Penetration Ratio

Definition: The ratio of business lines to total switched lines at which the processor feature loading multiplier is assumed to reach the "heavy business" value of 2. The assumption is that business lines may invoke more features and services. Therefore, business lines affect processor real time loading more than residential lines.

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[22] Northern Business Information study: U.S. Central Office Equipment Market – 1995, McGraw-Hill, New York, 1996.

Default Value: 0.30

Support: This is a Hatfield Associates estimate, which is used in lieu of forward looking alternatives from public sources or ILECs. It is based on consultations with AT&T and MCI subject matter experts.

4.2. WIRE CENTER

4.2.1. Lot size, multiplier of switch room size

Definition: The multiplier of switch room size to arrive at total lot size to accommodate building and parking requirements.

Default Value: 2

4.2.2. Tandem/EO wire center common factor

Definition: The percentage of tandem switches that are also end office switches. This accounts for the fact that tandems and end offices are often located together, and is employed to avoid double counting of switch common equipment and wire center investment in these instances.

Default Value: 0.4

4.2.3. Power investment

Definition: The wire center investment required for rectifiers, battery strings, back-up generators and various distributing frames, as a function of switch line size.

Default Values:

Lines	Investment Required
0	$5,000
1000	$10,000
5000	$20,000
25,000	$50,000
50,000	$250,000

4.2.4 Switch room size

Definition: The area in square feet required to house a switch and its related equipment.

Default Values:

Switch Room Size	
Lines	Sq. Feet of Floor Space Required
0	500
1,000	1,000
5,000	2,000
25,000	5,000
50,000	10,000

4.2.5. Construction costs, per sq. ft.

Definition: The costs of construction of a wire center building. Although cost per square foot generally decreases as building size increases, the construction cost per square foot increases with the number of lines served to account for higher prices typically associated with greater population densities.

Default Values:

Construction Costs per sq. ft.	
Lines	Cost/sq. ft.
0	$75
1,000	$85
5,000	$100
25,000	$125
50,000	$150

4.2.6. Land price, per sq. ft.

Definition: The land price associated with a wire center. Land cost per square foot increases with the number of lines served to account for higher prices typically associated with greater population densities.

Default Values:

Lines	Price/sq. ft.
0	$5.00
1,000	$7.50
5,000	$10.00
25,000	$15.00
50,000	$20.00

4.3. TRAFFIC PARAMETERS

4.3.1. Local Call Attempts

Definition : The number of yearly local call attempts, as reported to the FCC.

Default Value: Taken from ARMIS reports for the LEC being studied.

Support: ARMIS report 43-08.

4.3.2. Call Completion Fraction

Definition: The percentage of calls that result in a message. By this definition, calls that result in a busy

signal, no answer, or network blockage are all considered incomplete.

Default Value: 0.7

Support: Bell Communications Research, *LATA Switching Systems Generic Requirements*, Section 17: Traffic Capacity and Environment, TR-TSY-000517, Issue 3, March 1989. This number is a composite of the results shown in table 17.6-B.

4.3.3. IntraLATA Calls Completed

Definition : The number of yearly intraLATA completed call attempts, as reported to the FCC.

Default Value: Taken from ARMIS reports for the LEC being studied.

Support: ARMIS report 43-08.

4.3.4. InterLATA Intrastate Calls Completed

Definition : The number of yearly interLATA intrastate completed call attempts, as reported to the FCC.

Default Value: Taken from ARMIS reports for the LEC being studied.

Support: ARMIS report 43-08.

4.3.5. InterLATA Interstate Calls Completed

Definition : The number of yearly interLATA interstate completed call attempts, as reported to the FCC.

Default Value: Taken from ARMIS reports for the LEC being studied.

Support: ARMIS report 43-08.

4.3.6. Local DEMs, thousands

Definition : The number of yearly local DEMs, as reported to the FCC.

Default Value: Taken from FCC reports for the LEC being studied.

Support: See FCC Monitoring Report, Docket No. 87-339, May 1995.

4.3.7. Intrastate DEMs, thousands

Definition : The number of yearly intrastate DEMs, as reported to the FCC.

Default Value: Taken from FCC reports for the LEC being studied.

Support: See FCC Monitoring Report, Docket No. 87-339, May 1995.

4.3.8. Interstate DEMs, thousands

Definition : The number of yearly interstate DEMs, as reported to the FCC.

Default Value: Taken from FCC reports for the LEC being studied.

Support: See FCC Monitoring Report, Docket No. 87-339, May 1995.

4.3.9. Local bus/res DEMs ratio

Definition: The ratio of local Business DEMs per line to local Residential DEMs per line

Default Value: 1.1

Support: This is a Hatfield Associates estimate, which is used in lieu of forward looking alternatives from public sources or ILECs. It is based on consultations with AT&T and MCI subject matter experts.

4.3.10. Intrastate bus/res DEMs

Definition: The ratio of intrastate Business DEMs per line to intrastate Residential DEMs per line

Default Value: 2

Support: This is a Hatfield Associates estimate, which is used in lieu of forward looking alternatives from public sources or ILECs. It is based on consultations with AT&T and MCI subject matter experts.

4.3.11. Interstate bus/res DEMs

Definition: The ratio of interstate Business DEMs per line to interstate Residential DEMs per line

Default Value: 3

Support: This is a Hatfield Associates estimate, which is used in lieu of forward looking alternatives from public sources or ILECs. It is based on consultations with AT&T and MCI subject matter experts.

4.3.12. Busy hour fraction of daily usage

Definition: The percentage of daily usage that occurs during the busy hour.

Default Value: 0.10

Support: AT&T Capacity Cost Study.[23]

4.3.13. Annual to daily usage reduction factor

Definition: The effective number of business days in a year, used to concentrate annual usage into a fewer number of days as a step in determining busy hour usage.

Default Value: 270

Support: The AT&T Capacity Cost Study uses an annual to daily usage reduction factor of 264 days.[24]

4.3.14. Holding time multipliers, residential/business

Definition: The potential modification to the average call "holding time" (i.e., duration) to reflect Internet use or other causes, expressed as a multiplier of the holding time associated with ordinary residential or business telephone calls.

Default Values:

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[23] Blake, V.A., Flynn, P.V., Jennings, F.B., AT&T Bell Laboratories, "A Study of AT&T's Competitors' Capacity to Absorb Rapid Demand Growth," June 20, 1990, p.10. Filed in CC Docket No. 90-132.

[24] Ibid.

Holding time multipliers	
Residential	Business
1.0	1.0

Support: The purpose of this parameter is to allow users to effectively increase the offered load on the network. The default value of 1 means the load is that estimated from DEMs.

4.3.15. Call attempts, Busy Hour (BHCA), residential/business

Definition: The number of call attempts originated per residential and business subscriber during the busy hour.

Default Values:

Busy Hour Call Attempts	
Residential	Business
1.3	3.5

Support: Bell Communications Research, *LATA Switching Systems Generic Requirements*, Section 17: Traffic Capacity and Environment, TR-TSY-000517, Issue 3, March 1989. This number is a composite of the results shown in table 17.6 C-G.

4.4. INTEROFFICE INVESTMENT

4.4.1. Transmission Terminal Investment

Definition: The investment in the add-drop multiplexers (ADMs) that extract/insert signals into OC-48 fiber rings, and are needed in each wire center to connect to the interoffice fiber ring or point to point circuit.

Default Values:

Transmission Terminal Investment			
OC-48 ADM, Installed		OC-3/DS-1 Terminal Multiplexer, Installed	Investment per 7 DS-1s
48 DS-3s	12 DS-3s	84 DS-1s	
$50,000	$40,000	$26,000	$500

4.4.2. Number of fibers

Definition: The assumed fiber cross-section, or number of fibers in a cable, in the interoffice fiber ring and point to point network.

Default Value: 24

Support: The default value is consistent with common practices within the telecommunications industry and reflects the engineering judgement of Hatfield Model developers.

4.4.3. Pigtails

Definition: The cost of the short fiber connectors that attach the interoffice ring fibers to the wire center transmission equipment via a patch panel.

Default Value: $60.00 per pigtail

Support: A public source estimates the cost of pigtails at $75.00 per fiber. See, Reed, David P., Residential Fiber Optic Networks and Engineering and Economic Analysis, Artech House, Inc., 1992, p.93.

4.4.4 Optical Distribution Panel

Definition: The cost of the physical fiber patch panel used to connect 24 fibers to the transmission equipment.

Default Value: $1,000.00

Support: The cost for an installed fiber optic patch panel, including splicing of the fibers to pigtails, was estimated by a team of experienced outside plant experts who have contracted for hundreds of such installations. A fiber optic patch panel contains no electronic, nor moving parts, but allows for the physical cross connection of fiber pigtails.

4.4.5. EF&I, per hour

Definition: The per-hour cost for the "engineered, furnished, and installed" activities for equipment in each wire center associated with the interoffice fiber ring, such as the "pigtails" and patch panels to which the transmission equipment is connected.

Default Value: $55.00

Support: This is a fully loaded labor rate used for the most sophisticated technicians. It includes basic wages and benefits, Social Security, Relief & Pensions, management supervision, overtime, exempt material and motor vehicle loadings. This value was estimated by a team of experienced outside plant experts.

4.4.6. EF&I, units

Definition: The number of hours required to install the equipment associated with the interoffice transmission system (see EF&I, per hour, above).

Default Value: 32 hours

Support: This amount of labor was estimated by a team of experienced engineering experts. It includes the labor hours to install and test the transport equipment involved in interoffice facilities.

4.4.7. Regenerator investment, installed

Definition: The installed cost of an OC-48 optical regenerator.

Default Value: $15,000

Support: This approximation was obtained from a representative of a major fiber optic multiplexer manufacturer at Supercom '96, in June 1996 in Dallas, Texas.

4.4.8. Regenerator spacing, mi.

Definition: The distance between digital signal regenerators in the interoffice fiber optics transmission system.

Default Value: 40 mi.

Support: Based on field experience of maximum distance before fiber regeneration is necessary. Representative values from vendor information; Fujitsu product literature states 101km.

4.4.9. Channel Bank Investment, per 24 lines

Definition: The investment in voice grade to DS-1 multiplexers in wire centers required for some special access circuits.

Default Value: $5,000

4.4.10. Fraction of SA Lines Requiring Multiplexing

Definition: The percentage of special access circuits that require voice grade to DS-1 multiplexing in the wire center in order to be carried on the interoffice transmission system.

Default Value: 0.50

4.4.11. Digital Cross Connect System, Installed, per DS-3

Definition: The investment required for a digital cross connect system that interfaces DS-1 signals between switches and OC-3 multiplexers, expressed on a per DS-3 basis (672 DS-0).

Default Value: $30,000

4.4.12. Transmission Terminal Fill (DS-0 level)

Definition: The fraction of maximum DS-0 circuit capacity that can actually be utilized in ADMs and DS-1 to OC-3 multiplexers.

Default Value: 0.90

Support: Based on outside plant subject matter expert judgement.

4.4.13. Interoffice Fiber Cable investment per foot, installed

Definition: The installed cost per foot of interoffice fiber cable, assuming a 24-fiber cable.

Default Value: $3.50 installed

Support: See discussion in section 3.4.2.

4.4.14. Number of Strands per ADM

Definition: The number of interoffice fiber strands connected to the ADM in each wire center. At least four are required around the ring.

Default Value: 4

Support: This is the standard number of strands required by an ADM. It provides for redundant transmission in both directions around the interoffice fiber ring.

4.4.15. Interoffice Structure Percentages

Definition: The relative amounts of different structure types supporting interoffice transmission facilities. Aerial cable is attached to telephone poles or buildings, buried cable is laid directly in the earth, and underground cable runs through underground conduit. Aerial and buried percentages are entered by the user; the underground fraction is then computed.

Default Values:

Structure Percentages		
Aerial %	Buried %	Underground %
20%	60%	20%

Support: This is an average figure accounting for the mix of density zones applicable to interoffice transmission facilities.

4.4.16. Transport Placement

Definition: The cost of placement of fiber cable used in the interoffice transmission system.

Default Values:

Transport Placement, per foot	
Buried	Conduit
$1.77	$16.40

Support: This is an average figure accounting for the mix of density zones applicable to interoffice transmission facilities.

4.4.17. Buried Sheath Addition

Definition: The cost of dual sheathing for additional mechanical protection of fiber interoffice transport cable.

Default Value: $0.20/foot

Support: See discussion in section 3.2.5.

4.4.18. Interoffice conduit, cost and number of tubes

Definition: The cost per foot for interoffice fiber cable conduit, and the number of spare tubes (conduit) placed per route.

Default Values: Cost/ft. $0.60
Spare tubes per route 1

Support: See discussion in sections 2.4.3. and 2.4.4.

4.4.19. Pullbox Spacing

Definition: Spacing between pullboxes in the interoffice portion of the network.

Default Value: 2,000 ft.

Support: See discussion in section 3.2.4.

4.4.20. Pullbox Investment

Definition: Investment per fiber pullbox in the interoffice portion of the network.

Default Value: $500

Support: See discussion in section 3.7.

4.4.21. Pole Spacing, Interoffice

Definition: Spacing between poles supporting aerial interoffice fiber cable.

Default Value: 150 feet

Support: This is a representative figure accounting for the mix of density zones applicable to interoffice transmission facilities.

4.4.22. Interoffice pole material and labor

Definition: The installed cost of a 40' Class 4 treated southern pine pole.

Default Values:

Pole Investment	
Materials	$201
Labor	$216
Total	*$417*

Support: See discussion in section 2.4.1.

4.4.23. Fraction Interoffice Structure Common With Feeder

Definition: The percentage of structure supporting interoffice transport facilities that is also shared by feeder facilities, expressed as a fraction of the smaller of the investment in the three types of facilities (aerial, buried and underground are treated separately).

Default Value: .75

Support: Interoffice transport facilities will almost always follow major feeder routes which radiate from each central office. There is a limited distance between adjacent central office feeder routes which require the building of structure. Since this portion of the adjacent feeder routes do not provide for feeder cable, that structure is most appropriately assigned exclusively to interoffice transport. In the opinion of several expert engineers, this additional structure required exclusively for interoffice transport is no more than 25 percent of the distance. Therefore, 75 percent of the interoffice route is assumed by the HM 3.1 to be shared with feeder cables.

4.4.24. Fraction of interoffice structure assigned to telephone

Definition: The fraction of investment in interoffice poles and trenching that is assigned to LECs. The remainder is attributed to other utilities/carriers

Default Values:

Fraction of Interoffice Structure Assigned to Telephone		
Aerial	Buried	Underground
.33	.33	.33

Support: The structure sharing covered by this parameter involves that structure which is not shared with feeder cable. At the end of the route, this sharing is assumed to include at least two other occupants of the structure, exclusive of feeder cable. Candidates for sharing include electrical power, CATV, competitive

long distance carriers, competitive local access providers, municipal services and others.

4.5. TRANSMISSION PARAMETERS

4.5.1. Operator traffic fraction

Definition: Fraction of traffic that requires operator assistance. This assistance can be automated or manual (see Operator Intervention Fraction in the Operator Systems section below)

Default Value: 0.02

4.5.2. Total interoffice traffic fraction

Definition: The fraction of all calls that are completed on a switch other than the originating switch, as opposed to calls completed within a single switch.

Default Value: 0.65

Support: According to Engineering and Operations in the Bell System, the most recent information source found to date, the percentage of calls that are interoffice calls ranges from 34 percent for suburban areas to 71 percent for urban areas. Weighted according to the typical number of lines per wire center for each environment (urban, suburban, rural), this averages to .64.

4.5.3. Maximum trunk occupancy, CCS

Definition: The maximum utilization of a trunk during the busy hour.

Default Value: 27.5

Support: AT&T Capacity Cost Study.[25]

4.5.4. Trunk port investment, per end

Definition: Per trunk equivalent investment in switch trunk port at each end of a trunk.

Default Value: $100

Support: AT&T Capacity Cost Study.[26] A Hatfield Associates assumption is that $100 is for the switch port itself.

4.5.5. Direct-routed fraction of local inter-office

Definition: The amount of local interoffice traffic that is directly routed between originating and terminating end offices as opposed to being routed via a tandem switch.

Default Value: 0.98

Support: The direct routed fraction of local interoffice is based on data filed by the LECs in response to an FCC data request issued in Docket 80-286: *In the Matter of Amendment of Part 36 of the Commission's Rules and Establishment of a joint Board*, Docket 80-286, Order, December 1, 1994, 9 FCC Rcd 7962

[25] "A Study of AT&T's Competitors' Capacity to Absorb Rapid Demand Growth," *supra.*, note 26, p.4.

[26] "A Study of AT&T's Competitors' Capacity to Absorb Rapid Demand Growth," *supra.*, note 26, p. 7.

(1994). See Universal Service Fund Data Request, File 1 of 4, page 8 of 11, 9 FCC Rcd 7962, 7976.

4.5.6. Tandem routed fraction of total intraLATA traffic

Definition: Fraction intraLATA calls that are routed through a tandem.

Default Value: 0.2

Support: The tandem routed fraction of total intraLATA traffic is based on data filed by the LECs in response to an FCC data request issued in Docket 80-286: *In the Matter of Amendment of Part 36 of the Commission's Rules and Establishment of a joint Board*, Docket 80-286, Order, December 1, 1994, 9 FCC Rcd 7962 (1994). See Universal Service Fund Data Request, File 1 of 4, page 8 of 11, 9 FCC Rcd 7962, 7976.

4.5.7. Tandem routed fraction of total interLATA traffic

Definition: Fraction of interLATA (IXC access) calls that are routed through a tandem instead of directly to the IXC.

Default Value: 0.2

Support: The tandem routed fraction of total interLATA traffic is based on data filed by the LECs in response to an FCC data request issued in Docket 80-286: *In the Matter of Amendment of Part 36 of the Commission's Rules and Establishment of a joint Board*, Docket 80-286, Order, December 1, 1994, 9 FCC Rcd 7962 (1994). See Universal Service Fund Data Request, File 1 of 4, page 8 of 11, 9 FCC Rcd 7962, 7976.

4.5.8. POPs per Tandem Location

Definition: The number of IXC points of presence requiring an entrance facility, per LEC tandem.

Default Value: 5

Support: An assumption that includes three principal IXCs plus two smaller carriers.

4.6. TANDEM SWITCHING

4.6.1. Real time limit, BHCA

Definition: The maximum number of BHCA a tandem switch can process.

Default Value: 750,000

Support: Industry experience and expertise of Hatfield Associates. These numbers are well within the range of the BHCA limitations NORTEL supplies in its Web site. See 4.1.1.

4.6.2. Port limit, trunks

Definition: The maximum number of trunks that can be terminated on a tandem switch.

Default Value: 100,000

Support: AT&T Updated Capacity Cost Study.[27]

[27] "An Updated Study of AT&T's Competitors' Capacity to Absorb Rapid Demand Growth," April 19, 1995, compiled by AT&T Bell Laboratories, p. 9.

4.6.3. Tandem common equipment investment

Definition: The amount of investment in tandem switch common equipment, which is the hardware and software that is present in the tandem in addition to the trunk terminations themselves. The cost of a tandem is estimated by the HM as the cost of common equipment plus an investment per trunk terminated on the tandem.

Default Value: $1,000,000

Support: AT&T Capacity Cost Study.[28]

4.6.4. Maximum trunk fill (port occupancy)

Definition: The fraction of the maximum number of trunk ports on a tandem switch that can be utilized.

Default Value: 0.90

Support: This is a Hatfield Associates estimate, which is used in lieu of forward looking alternatives from public sources or ILECs. It is based on consultations with AT&T and MCI subject matter experts.

4.6.5. Maximum tandem real time occupancy

Definition: The fraction of the total capacity (expresses as the real time limit, BHCA) a tandem switch is allowed to carry.

Default Value: 0.9

Support: Bell Communications Research, *LATA Switching Systems Generic Requirements*, Section 17: Traffic Capacity and Environment, TR-TSY-000517, Issue 3, March 1989, figure 17.5-1, p. 17-24.

4.6.6. Tandem common equipment intercept factor

Definition: The multiplier of the common equipment investment input that gives the common equipment cost for the smallest tandem switch.

Default Value: 0.50

Support: Value selected to allow tandem common equipment investment to range from $500,000 to $1,000,000, allowing scaling of tandem switching investment according to trunk requirements.

4.6.7. Entrance Facility Distance from Serving Wire Center & IXC POP

Definition: Average length of trunks connecting an IXC with the wire center that serves it.

Default Value: 0.5 miles

Support: Value selected in recognition of the fact that IXCs typically locate POPs close to the serving wire center to avoid long cable runs.

[28] "A Study of AT&T's Competitors' Capacity to Absorb Rapid Demand Growth," *supra.*, note 26, p.9.

4.7. SIGNALING

4.7.1. STP link capacity

Definition: The maximum number of signaling links that can be terminated on a given STP pair.

Default Value: 720

Support: AT&T Updated Capacity Cost Study.[29]

4.7.2. STP maximum fill

Definition: The fraction of maximum links, as stated by the STP link capacity input, that the model assumes can be utilized before it adds another STP pair.

Default Value: 0.8

Support: AT&T Updated Capacity Cost Study.[30]

4.7.3. STP maximum common equipment investment, per pair

Definition: The cost to purchase and install an STP pair.

Default Value: $5,000,000

Support: AT&T Updated Capacity Cost Study.[31]

4.7.4. STP minimum common equipment investment, per pair

Definition: The minimum investment for a minimum-capacity STP, i.e.: the fixed investment for an STP pair that serves a minimum number of links.

Default Value: $1,000,000

Support: AT&T Updated Capacity Cost Study.[32]

4.7.5. Link termination, both ends

Definition: The investment required for the transmission equipment that terminates both ends of an SS7 signaling link.

Default Value: $900.00

Support: AT&T Updated Capacity Cost Study.[33]

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[29] "An Updated Study of AT&T's Competitors' Capacity to Absorb Rapid Demand Growth," *Supra.*, note 30, p. 26.

[30] "An Updated Study of AT&T's Competitors' Capacity to Absorb Rapid Demand Growth," *Supra.*, note 30, p. 26.

[31] "An Updated Study of AT&T's Competitors' Capacity to Absorb Rapid Demand Growth," *Supra.*, note 30, p. 26.

[32] "An Updated Study of AT&T's Competitors' Capacity to Absorb Rapid Demand Growth," *Supra.*, note 30, p. 26.

4.7.6. Signaling link bit rate

Definition: The rate at which bits are transmitted over an SS7 signaling link.

Default Value: 56,000 bits per second

Support: The AT&T Updated Capacity Cost Study used a signaling link bit rate of 56,000 bps which is an SS7 network industry standard.[34]

4.7.7. Link occupancy

Definition: The fraction of the maximum bit rate that can be sustained on an SS7 signaling link.

Default Value: 0.40

Support: AT&T Updated Capacity Cost Study.[35]

4.7.8. C link cross-section

Definition: The number of C-links in each segment connecting a mated STP pair.

Default Value: 24

Support: The input was derived assuming the 56 kbps signaling links between STPs are normally transported in a DS-1 signal, whose capacity is 24 DS-0s.

4.7.9. ISUP messages per interoffice BHCA

Definition: The number of Integrated Services Digital Network User Part (ISUP) messages associated with each interoffice telephone call attempt, i.e. the messages switches send to each other over the SS7 network to negotiate establishing a voice path.

Default Value: 6

Support: AT&T Updated Capacity Cost Study.[36]

4.7.10. ISUP message length, bytes

Definition: The average number of bytes in each ISUP (ISDN User Part) message.

Default Value: 25 bytes

Support: Bellcore Technical Reference TR-NWT-000317, Appendix A, shows that 25 bytes per message is a conservatively high figure. Northern Telecom's DMS-STP product/service information booklet shows

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[33] "An Updated Study of AT&T's Competitors' Capacity to Absorb Rapid Demand Growth," *Supra.*, note 30, p. 26.

[34] "An Updated Study of AT&T's Competitors' Capacity to Absorb Rapid Demand Growth," *Supra.*, note 30, p. 25.

[35] "An Updated Study of AT&T's Competitors' Capacity to Absorb Rapid Demand Growth," *Supra.*, note 30, p. 24.

[36] "An Updated Study of AT&T's Competitors' Capacity to Absorb Rapid Demand Growth," *Supra.*, note 30, p. 25.

an average ISUP message length of 25 bytes.[37]

4.7.11. TCAP messages per transaction

Definition: The number of Transaction Capabilities Application Part (TCAP) messages required per SCP database query. A TCAP message is a message from a switch to a database or another switch that provides the switch with additional information prior to setting up a call or completing a call.

Default Value: 2

Support: AT&T Updated Capacity Cost Study.[38]

4.7.12. TCAP message length, bytes

Definition: The average length of a TCAP message.

Default Value: 100 bytes

Support: Bellcore Technical Reference TR-NWT-000317, Appendix A, shows that 100 bytes per message is a conservatively high figure. Northern Telecom's DMS-STP product/service information booklet shows an average TCAP message length of 85 bytes.[39]

4.7.13. Fraction of BHCA requiring TCAP

Definition: The percentage of BHCAs that require a database query, and thus generate TCAP messages.

Default Value: 0.10

Support: Based on data from the interexchange industry, 10% is a conservatively high number for the local industry.

The AT&T Updated Capacity Cost Study assumes that 50% of all calls require a database query, but that is not an appropriate number to use in the HM because a substantial fraction of IXC calls are toll-free (800) calls.[40] Reduced to reflect the fact that a large majority of calls handled by the LECs are local calls that do not require such a database query, the 50% would be less than 10%; HAI has used the 10% default as a conservatively high estimate.

4.7.14. SCP investment per transaction per second

Definition: The investment in the Service Control Point (SCP) associated with database queries, or transactions, stated as the investment required per transaction per second. For example, an SCP required to handle 100 transactions per second would require a 2 million dollar investment, if the default of $20,000 is assumed.

Default Value: $20,000

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[37] Northern Telecom, DMS-STP Planner 1995, Product/Service Information, 57005.16, Issue 1, April, 1995, p.13.

[38] "An Updated Study of AT&T's Competitors' Capacity to Absorb Rapid Demand Growth," *Supra.*, note 30, p. 25.

[39] DMS-STP Planner 1995, *supra.*, note 40, p.13.

[40] "An Updated Study of AT&T's Competitors' Capacity to Absorb Rapid Demand Growth," *Supra.*, note 30, p. 25.

Support: AT&T Updated Capacity Cost Study uses a default value of $30,000 from a 1990 study, but notes that this is "conservatively high because of the industry's advances in this area and the resulting decrease in technology costs since the 1990 study."[41] The default value used in the HM represents the judgment of HAI as to the reduction of such processing costs since then.

4.8. OS AND PUBLIC TELEPHONE

4.8.1. Investment per operator position

Definition: The investment per computer required for each operator position.

Default Value: $6,400

4.8.2. Maximum utilization per position, CCS

Definition: The estimated maximum number of CCS that one operator position can handle during the busy hour.

Default Value: 32

4.8.3. Operator intervention factor

Definition: The percentage of all operator-assisted calls that require operator intervention, expressed as 1 out of every N calls, where N is the value of the input. Given the default values for operator-assisted calls, this parameter means that 1/10 or 10% of the assisted calls actually require manual intervention of an operator, as opposed to *automated* operator assistance for credit card calls, etc.

Default Value: 10

4.8.4. Public Telephone equipment investment per station

Definition: The weighted average cost of a public telephone and pedestal (coin/non-coin and indoor/outdoor).

Default Value: $760

Support: New England Incremental Cost Study.[42]

4.9. ICO PARAMETERS

4.9.1. ICO STP Investment per Line

Definition: The surrogate value for equivalent per line investment by a small independent telephone company.

Default Value: $5.50

Support: The average STP investment per line from the Hatfield Model, with 20 percent added to reflect a return on investment for the providing carrier.

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[41] "An Updated Study of AT&T's Competitors' Capacity to Absorb Rapid Demand Growth," *Supra.*, note 30, p. 27.

[42] New England Telephone Company, "1993 New Hampshire Incremental Cost Study," p. 90.

4.9.2. Per Line ICO Local Tandem Investment

Definition: The surrogate value for the per line investment in a local tandem switch by an independent telephone company (ICO), in lieu of calculating it directly in the model.

Default Value: $1.90

Support: The average local tandem investment per line from the Hatfield Model, with 20 percent added to reflect a return on investment for the providing carrier.

4.9.3. Per Line ICO OS Tandem Investment

Definition: The surrogate value for the per line investment in an Operator Services tandem switch by an independent telephone company (ICO), in lieu of calculating it directly in the model.

Default Value: $0.80

Support: The average OS tandem investment per line from the Hatfield Model, with 20 percent added to reflect a return on investment for the providing carrier.

4.9.4. Per Line ICO SCP Investment

Definition: The surrogate value for the per line investment in a SCP by an independent telephone company (ICO), in lieu of calculating it directly in the model.

Default Value: $2.50

Support: The average SCP investment per line from the Hatfield Model, with 20 percent added to reflect a return on investment for the providing carrier.

4.9.5. Per Line ICO Local Tandem Wire Center Investment

Definition: The surrogate value for the per line investment in a local tandem wire center by an independent telephone company (ICO), in lieu of calculating it directly in the model.

Default Value: $2.50

Support: The average local tandem wire center investment per line from the Hatfield Model, with 20 percent added to reflect a return on investment for the providing carrier.

4.9.6. Per Line ICO OS Tandem Wire Center Investment

Definition: The surrogate value for the per line investment in a operator services tandem wire center by an independent telephone company (ICO), in lieu of calculating it directly in the model.

Default Value: $1.00

Support: The average OS tandem wire center investment per line from the Hatfield Model, with 20 percent added to reflect a return on investment for the providing carrier.

4.9.7. Per Line ICO STP/SCP Wire Center Investment

Definition: The surrogate value for the per line investment in an STP/SCP wire center by an independent telephone company (ICO), in lieu of calculating it directly in the model.

Default Value: $.40

Support: The average STP/SCP wire center investment per line from the Hatfield Model, with 20 percent added to reflect a return on investment for the providing carrier.

4.9.8. Per Line ICO C-Link / Tandem A-Link Investment

Definition: The surrogate value for the per line investment in a C-link / tandem A-link by an independent telephone company (ICO), in lieu of calculating it directly in the model.

Default Value: $0.30

Support: The average C-Link / tandem A-link investment per line from the Hatfield Model, with 20 percent added to reflect a return on investment for the providing carrier.

5. EXPENSE

5.1. COST OF CAPITAL AND CAPITAL STRUCTURE

Definition: The capital cost structure, including the debt/equity ratio, cost of debt, and return on equity, that make up the overall cost of capital.

Default Values:

Debt percent	0.450
Cost of debt	0.077
Cost of equity	0.119
Weighted average cost of capital	*0.1001*

Support: Based on FCC-approved cost of capital methodology using 1996 financial data and AT&T and MCI-sponsored DCF and CAPM analyses calculating the RBOCs' cost of capital. See, for example, "Statement of Matthew I. Kahal Concerning Cost of Capital," In the Matter of Rate of Return Prescription for Local Exchange Carriers," File No. AAD95-172, March 11, 1996. See also earlier ex parte filing on this subject.

5.2. DEPRECIATION

Definition: The economic life of various network plant categories.

Default Values:

Plant Type	Economic Life
motor vehicles	9.16
garage work equipment	11.47
other work equipment	13.22
buildings	48.99
furniture	16.56
office support equipment	11.25
company comm. Equipment	7.59
general purpose computers	6.24
digital electronic switching	16.54
operator systems	9.94
digital circuit equipment	10.09
public telephone term equipment	8.01
Poles	16.13
aerial cable, metallic	16.80
aerial cable, non metallic	22.11
underground cable, metallic	21.17
underground cable, non metallic	22.87
buried cable, metallic	19.86
buried cable, non metallic	24.13
intrabuilding cable, metallic	15.64
intrabuilding cable, non metallic	23.65
conduit systems	51.35

Support: The default values are the weighted average set of projected depreciation lives, adjusted for net salvage, coming from all the BOCs and SNET. Weighting is based on total lines per operating company. The projected depreciation lives are determined in a triennial review process involving each state PUC, the FCC, and the LEC to establish unique state-and-operating-company-specific depreciation schedules. See, FCC Public Notice D.A. #'s 95-1635, 93-970, 96-1175, 94-856, 95-1712. NID and SAI lives are calculated at the average life of metallic cable.

5.3. STRUCTURE SHARING FRACTION

Definition: The fraction of investment in distribution and feeder poles and trenching that is assigned to LECs. The remainder is attributed to other utilities/carriers.

Default Values: